DOCUMENT RESUME

ED 096 890 HE 005 917

AUTHOR Puri, O. P.
TITLE Cooperative General Science Program. Progress Report 1966-74.
INSTITUTION Clark Coll., Atlanta, Ga.
PUB DATE 30 Jun 74
NOTE 62p.

EDRS PRICE MF-$0.75 HC-$3.15 PLUS POSTAGE
DESCRIPTORS Curriculum Development; Experimental Programs; *General Science; *Higher Education; *Interinstitutional Cooperation; *Program Descriptions; Program Evaluation; *Science Programs; Undergraduate Study
IDENTIFIERS *Atlanta University Center

ABSTRACT

This is a final report on an experimental program in curriculum development. Four undergraduate colleges in the Atlanta University Center (Clark, Morehouse, Morris Brown, and Spelman) have cooperated to develop a 1-year course in general science for use in liberal arts colleges. This program has proven successful in developing and presenting materials of science to undergraduate liberal arts majors. Briefly speaking, the approach was conceptual and developmental in character. It was the aim of the course to teach students to understand the many facets of science; such as, the origin of science, the uniqueness of the scientific inquiry, the development of scientific ideas, what was actually taught by the leaders and innovators of science, what developments have taken place, something of the content of technology, how problems are solved, the strengths and weaknesses of scientific thought, philosophical considerations of science, historical impacts, and the hierarchy and relative value in science of concepts, such as verification, experiment, theory, hypothesis, probability, certainty, and validity. This document contains a report on the aims of the program, the progress in classroom teaching, a student evaluation questionnaire, faculty evaluation, student contracts, and a list of visiting lectures and consultants. (Author/PG)

ED 096890

COOPERATIVE GENERAL SCIENCE PROGRAM

Clark College, Atlanta, Georgia 30314

Clark
Morehouse
Morris Brown
and Spelman
Colleges

Progress Report 1966-74

National Center for Higher Educa

Clark College
Atlanta, Georgia
U.S.A.

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O. P. PURI
Director

HE 005 917

ACKNOWLEDGMENTS

This Progress Report could not be completed without help from many individuals. To these persons, too numerous to mention, who have contributed to the preparation of this report, we are grateful.

We wish to thank the many teachers and students whose comments have been most helpful through the years.

We would like to express special thanks to the United States Office of Education (Title III) for the financial support of this program. It has contributed greatly to the improvement of our academic program, and it is hoped that our efforts in producing these materials will be of interest and benefit to other educational institutions. In particular, we would like to express sincere gratitude to Dr. Willa B. Player whose thoughtfulness and generous support was significant and influential.

We are grateful, also to the administrations of the four participating colleges, to Presidents Vivian W. Henderson, Hugh M. Gloster, Robert Threatt and Albert E. Manley for their foresight in establishing this program.

We owe special thanks to the various chairmen of the departments who encouraged this program and to the Deans of the various colleges for their cooperation.

We cannot conclude this report without expressing our great appreciation for the time, thought, imaginative aid and judgment given over the past eight years by President Henderson of Clark College.

Finally, we express the hope that this report will prove helpful to colleges and universities, and that it will advance the cause of good science teaching to liberal arts majors.

June 30, 1974

Atlanta, Georgia
U.S.A.

O. P. Puri, Director
Garfield D. Merner Professor
Clark College

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COOPERATIVE GENERAL SCIENCE PROGRAM

A REPORT ON ITS AIMS AND PROGRESS

INTRODUCTION

This is a final report on an experimental program in curriculum development which has involved, so far, about fifty scientists. Four undergraduate colleges in the Atlanta University Center (*Clark, Morehouse, Morris Brown and Spelman*) have cooperated to develop a one-year course in general science for use in liberal arts colleges. In 1965, we began a study with the belief that a new curriculum using an integrated introduction to science would be beneficial. The funds were granted by the U. S. Office of Education and work began in July, 1966. To date, we have received approximately 1.5 million dollars to do this experiment in curriculum development.

The current version of course and laboratory materials have been tried in the Atlanta University center colleges by 15,000 students on a controlled experimental basis over the past eight years. The materials we develop and produced have been used by over one hundred colleges in the United States and abroad. This usage involves several thousand students. The students who plan to become the lawyers, artists, historians, sociologists, theologians, and teachers of tomorrow are the premise for our program. In this program , we have been successful in developing and presenting materials of science to undergraduate liberal arts majors. We took the mixed group of majors, as stated above, and devised

a curriculum and a set of activities which constitutes a one year course in general science. Briefly speaking, the approach is conceptual and developmental in character. It is our aim to teach students to understand the many facets of science; such as, the origin of science, the uniqueness of the scientific inquiry, the development of scientific ideas, what was acutally taught by the leaders and innovators of science, what developments have taken place, something of the content of technology, how problems are solved, the strengths and weaknesses of scientific thought, philosophical considerations of science, historical impacts, and the hierarchy and relative value in science of concepts such as verification, experiment, theory, hypothesis, probability, certainty, validity, and other related considerations of a logical nature.

WHY DO WE NEED SUCH A GENERAL SCIENCE PROGRAM?

Although the four undergraduate colleges in the Atlanta University Center (*Clark, Morehouse, Morris Brown and Spelman*) have cooperated in some areas of curriculum offerings for several years, each of the colleges had a different offering in science for non-science students until the formation of the Cooperative General Science Program. The program helped to bring about a uniformity in science requirements for non-science students by all of the colleges and has helped develop more cooperative efforts in all areas of academic concerns.

Through the efforts of the Cooperative General Science Program a one year course, offering six semester hours credit, has been developed and is continuously being revised as the need for changes becomes apparent

in the teaching of the course. The schedule of instruction provides for three one-hour lectures each week and a two-hour laboratory session. The course material has been divided into eight (8) basic units, each of which is meant to occupy four (4) to five (5) weeks of instruction time. This is a multi-disciplinary integrated approach and the units include: physics, chemistry, astronomy, geology, life and evolution, heredity and genetics, ecology and population, as well as economy of life and resources. The first four portions are taught in one semester by physical scientists and the last four portions are taught in one semester by biologists.

The course has been designed in such a manner that it is not necessary for students to take the courses in sequence. Some students may desire to take the second portion of the course before taking the first. We feel this gives more flexibility to individual student's choice and to scheduling problems. The course may be taken by the undergraduate during any year; although, the majority of the students take it during their freshman year.

The program is intended to give students majoring in the humanities and the social sciences a firm background in physical and biological science. It emphasizes the most important changes in science that have taken place over the last several hundred years. It helps the non-science major relate these changes to the effects they have had and are having on our society.

Rather than making this course a *"watered-down"* version of a conventional course designed for science majors, emphasis was made to those principles of science which can be of practical benefit to liberal arts

majors. In the areas related to physical science, we have concentrated on establishing an understanding of the concepts involved, with less emphasis upon the utilization of mathematical principles. In the areas related to biological science, we have concentrated on the concepts which can give the individual a clearer understanding of the human biological processes.

We were encouraged by the favorable response the program received. There seems to be an indication that we were "*breaking through*" and reaching the students because of their interest in researching information and inquiry into a course that was previously unnattractive to them. We have received letters of appreciation from students who took the course. At the end of each course, an evaluation sheet containing several questions was distributed to each student. No names were placed on this sheet and the evaluations represented a true evaluation of the students feelings. The consensus of opinion was very favorable. The program was structured to provide for student response and feedback.

THE PURPOSE OF THIS PROGRAM:

A. *To teach the students the essential content, the significance, and the harmony of the scientific concern by presenting selected portions from the materials of the physical and biological sciences.*

B. *To stress the humanistic background, the origin and development of science, with the interrelation and unity of science.*

C. *To provide some insight into those areas where science has had an impact on our past and to explore areas where science and society intermingle in the present.*

D. *To show students that the achievements of science first alter the thinking of individuals, then becomes embedded in their institutions, and finally become a part of man's cultural life and practice.*

THE ACADEMIC PROGRAM

The program is designed to offer a wide area of exposure to the physical and biological sciences to liberal arts majors who are involved in a very restricted way with science at a minimum level. The course offerings include formal lectures, laboratory sessions, and a few field trips and special sessions.

The Physical Science segment consist of the following topics: "Definition and Development of Basic Mathematical Concepts", "Historical Development of Concepts of Motion and Gravitation", "The Solar System","The Structure of Matter," "Physical and Chemical Change", "Energy and Heat Phenomena, Electricity, Magnitism and Light", "Evolution of the Earth and Continental Drifts", "Philosophical and Cultural Aspects of Science".

Laboratory exercises, sessions and experiments are conducted to study selected topics. A few field trips and special sessions make it possible for the student to come into direct contact with some of the things considered in the classroom. Audiovisual materials and equipment are employed to augment and extend the student's knowledge whenever possible.

The Biological Science's topics are: "Biology and the Future of Man," "Chemistry and Life," "Levels of Biological Organization", "Bioenergetics", "Regulation of the Internal Environment", "The Human Body - Systems and Diseases", "Reproduction, Growth and Development," "Principles of Genetics and Human Heredity", "Biological Change - Origin and Evolution of Life", "Individuals,

Populations and the Environment", "Conservation of Natural Resources".

Related laboratory exercises are investigative in nature. Some investigations serve to develop skills. Some investigations involve collecting, organizing and making inferences from raw data and others introduce, clarify or summarize textbook and lecture offerings. The graphic arts and audio visual materials and equipment are utilized to promote the student's understanding. Field trips and discussions round out the program of instruction.

SPECIAL EVENTS

Distinguished lecturers are brought into the classroom whose accomplishments and competence provide an academic setting for an interesting and informative dialogue with the students. Classroom demonstrations of interesting phenomena are used to rivet the student's attention, provoke curiosity, and stimulate the imagination. Questions and discussions follow that explicate new aspects of science, promote understanding, and provide a basis for achieving an orientation to a wide area of scientific enterprise.

LECTURE MATERIALS

To satisfy all non-science majors, the course cannot be simple a traditional physics, chemistry, astronomy, geology, biology or social science course. A good integration of topics was developed from the sciences to begin a curriculum which relates to the experiences and interests of liberal arts majors. We feel this course should be taught during the freshman year in order to promote a basic understanding of certain aspects of sci-

ence and its impact on society. The technical details are completely omitted as these do not serve any purpose for the group of students we are teaching.

CURRICULUM DEVELOPMENT

During our eight years of involvement in this program, we have developed a complete complement of educational materials, ideas, and techniques that any liberal arts college could use or adopt as a starting point in teaching science to liberal arts majors. We have a complete set of topics that can be used as a basis for a semester's course, or a one year course, in materials of science. Our physical science manual lists a sequence of experiments designed to follow the lecture topics. Our *"Concepts in Physical Science"* text, the laboratory exercise manual and the teacher's guide were written by our staff and give a detailed account of materials in science to be used in the course. They reflect our philosophy of teaching, our basic presupposition, and our approach to this educational problem. Our physical science materials are available from Addison-Wesley Publishing Company of Reading, Massachusetts.

The new experimental version of our biological science laboratory manual was written during the summer of 1973. It is entitled, *"Laboratory Investigations in Biological Science"* and is completely investigative in nature. The new manual approaches biology from the point of view that science is more a way of *"finding out"* than it is a body of organized facts. The new laboratory manual was tested in the classroom during the 1973-74 academic year. Based on findings during the testing period, the manual will be revised and published commercially.

Transparencies of illustrations are found to be very helpful for detailed understanding. There are several good films available for the teaching of this course. Excellent short sound films on scientific topics, within the framework of our curricula, are available for use in conjunction with the topics. Films dealing with historical and philosophical aspects of science are rare. A closed circuit television concept was developed and implemented. However, it did not generate any additional learning experience.

PROCEDURES OF THE PROGRAM

Essentially traditional efforts characterized our teaching activities. In order to teach science to liberal arts majors, lectures on various topics were employed. These topics were geared to their educational background. It is generally known that non-science students are weak in mathematics and have a disinclination toward analytical thinking. Also, these topics had to be tailored to fit the amount of time available for instruction.

Teaching liberal arts majors in a science classroom brings out, very clearly and very quickly, the difference between manipulation and understanding. No longer can any degree of inadequate understanding be hidden under a manipulative cloak. The liberal arts science students have little or no manipulative ability and no understanding of science. In this situation, the liberal arts student often assumes an attitude of withdrawal, characterized by fear or hostility. He neither understands the logical structure of science nor anything of its technical aspects, and, he feels swamped by the advancing activities of a growing technology all

around him. He reads or hears of scientific developments and achievements, often reported in superlative and exaggerated form; this causes him to place his intellectual efforts into some completely different concern. These and other facets necessitate a change in tone of what is being done in a science classroom. We must bring the materials of science to the students in a meaningful manner.

The classroom procedure was slanted heavily on the side of conceptualization of scientific materials and ideas to aid understanding and generate interest among liberal arts students. In addition to the lecture, the laboratory activities assumed the next rank of importance. Experiments had to be designed to augment the understanding of the student to enable him to grasp fundamental scientific concepts; and, provide an educational experience in science of interest and enjoyment.

Recitation groups were arranged in order that there would be time and opportunity for the student to freely express himself concerning any questions or details that arose during lecture periods, laboratory session, or assigned readings. The lecture periods, the laboratory groups, and the recitation periods made up the structure of teaching provided by the faculty. More will be said later on about the merits of these activities and what we feel was accomplished by each kind of activity discussed. The lectures and laboratory sessions were carried out under the direct supervision of instructors in laboratory sessions and a lecturer in the classroom or recitation session.

EQUIPMENT

The equipment purchased from 1966 to the present, has been a vital asset to the success of our program. The various items of equipment required for laboratory and classes were of good quality, standard make, in good repair, and adequate. It was new, well designed, and arranged to make for a minimum amount of lost motion in scheduling its use at different laboratory periods. Where it was workable, two or more students shared a set of apparatus for a laboratory project. On rare occasions, demonstrations were arranged and the equipment was operated by the instructor. The auxiliary equipment consisted of certain items kept in a central location and requisitioned from time to time by those having specific use for it. In general, there were no inadequacies or shortages as far as equipment was concerned. It was well cared for and remains with us for use in the future.

EVALUATION

The Cooperative General Science Program was conceived as a method of teaching science to non-science majors. It was presented as a new and innovative approach to the traditional Science Course for liberal arts majors, in that it approached the subject matter from a historical point of view and progressed to the present. Among several of its other unique characteristics is its cooperative nature; cooperating with four of the nation's oldest and most celebrated predominantly Black Colleges.

Over the past eight (8) years, we have been faced with the many difficulties and inadequacies of our program. It has been our endeavor to confront and overcome these, as they came to our attention, to the betterment of our program.

The most extensive problem that arose involved faculty and personnel. Due to the conceptual nature of our program, it required a very unique combination of instructional personnel. A person possessing the ability to put aside his specialized and technical training and impart his knowledge to the students on a conceptual level was an absolute necessity. Due to the vastness of our enrollment and the organization of our program, he must also be able to carry out his instruction using a specified format and a definite amount of time. Through the process of trial and error, we have accumulated a faculty that we feel is able to carry out our program as it was originally conceived. The professors, instructors and their assistants work together as a group to implement our method of teaching science to liberal arts majors. The number of individuals in each category is adequate and the various duties and their distribution among the several categories of individuals seems to work out satisfactorily.

Our staff now lectures on the same topics in their individual classes daily so that if a student misses one lecture, he can attend another. Naturally, if the lecturer feels that his students are not following or understanding, he will not continue just to keep up with the scheduled format, however, we find that the uniformity makes for an insured continuity of subject matter being presented to the students.

Our program is also faced with the problem of motivation. We naturally encounter students who have inborn aversions to science; these persons must be given the necessary motivation to enable them to complete our

course successfully and gain precious knowledge in the process. Thus, we must present the materials of science in a manner that will be useful and acceptable to students pursuing a liberal arts curriculum, as well as keep abreast of changing trends and accomplishments. This naturally creates a problem of presenting the "proper" subject matter.

The program was initially based on a historical approach to scientific concepts. However, over the span of eight years, science has taken on a more societal and environmental approach with emphasis on pollution, energy and other practical problems. Consequently, we have found the need to up-date our program and program materials to meet these changing demands. Our faculty and staff are continuously examining and evaluating our program materials for weak points, redundancy, and obsolete materials; and are trying to ianugurate materials that will be more meaningful and exciting to our students. We try to involve the students in the subject matter by allowing them the opportunity to research and investigate a particluar topic of their own choosing. This tends to create interest in some phase of science, as well as given them an opportunity to improve upon the necessary grade average.

SEMINARS

Extended time is provided for student participation and discussion of subject matter discussed in class or subject matters of an extra scientific or speculative nature. The students were given the choice of participating in a seminar or writing a term paper, most of the students elected the seminar and later stated that it was the most interesting part of the course.

We have gathered some excellently prepared materials on a wide variety of scientific subjects. Among these are sound movies, in black and white and color, as well as film strips and recorded tapes. We have arranged some materials in an accessible form so that students can avail themselves of the opportunities of learning through the medium of new and interesting methods of communication.

Our faculty and staff have also developed audiovisual material for several reasons; we needed some materials which were not available commercially and to increase the relevancy of science by using the college as a *"backdrop"*.

A one hour examination is given throughout the semester and they are graded and returned to the student. Three major examinations are conducted and, at the end of the course, a final examination is conducted which covers the entire semester's work. The students are also required to do written assignments. We have found this to be a means of familiarizing them with scientific reference materials, library research and the process of compiling and presenting such materials.

At the end of the semester, we designed and passed out a questionnaire to the students. The questions give the students an opportunity to comment, critize and offer suggestions concerning the course, as well as evaluate the instructor, and the program materials. There was a positive expression of satisfaction concerning laboratory work and the lectures were evaluated as *"good"* by the students. The student evaluations are

reviewed and considered in preparing for the following semester. We evaluate the opinions of students about the affairs of the program because they determine to a great extent how well the student learned the materials. We are constantly evaluating the reactions of our students to determine if we can make the course more relevant to them.

The student's reaction to the material, instruction and the instructor are determinate factors in our program; on the basis of this information, we have made some modifications and changes that serve the best interest of the program. We conduct personal interviews with students and these conferences result in a profit of understanding for us as well as the student.

PHYSICAL SCIENCE 1966 - 1974

This program has been in operation for eight (8) years and is concerned with communicating materials of science to liberal arts majors. The Physical Science division of our program has developed a format which will guide the presentation of its materials to the students. Since no science majors are enrolled in this course, the traditional kind of presentation was reviewed, both in content and purpose, and edited before being passed on as suitable for teaching liberal arts students. We feel that it places students at a disadvantage when they are given a "*watered-down*" version of what is being taught to science majors. We offer a course that, we feel, greatly rewards the efforts of both teachers and students. While presenting superficial concepts that can be undertook by students, confusion normally created by tedious mathematical operations is avoided. Also, the faculty is met with a genuine challenge when call-

ed upon to skim from their vast "*storehouse*" of knowledge a survey-type presentation.

The foregoing philosophy of work and approach then leaves one with the whole problem of putting together a mode and manner of teaching liberal arts students. We must also consider what materials to teach, once a format has been decided upon, that could be applied in a practical situtation. Our enrollment consisted of students with varied backgrounds and interests. Therefore, it became imperative to take under consideration the type of course work with which these students were accustomed - class room work with textbooks, library facilities, laboratory resources. All of these factors lead to a lecture room, laboratory exercise, self-study format in which the students could work. Consequently, we adopted a lecture method with reference to presentation of materials, augmented by laboratory sessions, and regularly required written assignments. These three aspects of work and study make up the regularly scheduled academic functions participated in by the students.

In designing a format, we faced decisions on what materials from science should be presented; what approach should be adopted; and what would be done to insure that the majority of the students in the course would derive benefit in his own area of interest. A presentation that leaves the student puzzled and uncertain as to what extent he has been benefited in his area of interest, naturally, would be a complete failure. Even the magic associated with the study of science, and the aura surrounding science, cannot bridge the feeling of uselessness that might arise in a student taking our course and finding no relevance between what had

been presented and what is interesting to him. The attempt to translate these ideas into a concrete program, that we feel accomplished these goals, represented an innovation and practical educational practice both in the area of method and the material presented.

The thinking which guided us reflected the considerations about science which were primarily conceptual, intuitive and qualitative in character. We considered matters that had a bearing on the outlook and interests of a liberal arts student, as well as matters that will concern a responsible citizen of our society. A course of study has been formulated and drawn up which brings the student into contact with instructors in lecture and laboratory sessions. The lectures are conceptually oriented and represents a genuine thrust of the intellect into materials of science. In these lectures, the instructor attempts to explicate the origins and roots of science. This cannot be done without some idea of what science is about, starting with the occurrences in Greece around 600 B.C. and proceeding to the present. The theoretical, experimental and philosophical aspects of science as it existed in the past is discussed. Every effort is made to impress on the student that science, both in its original form and in its present day practice, is a concern of mankind, and devoid of all forms of magic, and does not require a special talent to understand.

The topics of study were chosen in a manner so as to show both the pros and cons of opinion, and how each effected the evolution of science. The facts and the reasons for the antiquity of astronomy are discussed; the materials of the various early sciences are taught, as far as they

are known; Aristotle's formulation of the physical world is presented until it is seen to make sense and its strengths and weaknesses are explained. The sad plight of science in the West during the Middle Ages is discussed and its reawakening in the twelfth and thirteenth centuries. The glorious discoveries and rapid developments of a kind that is characterized as a revolution presented as best we know how and as thoroughly as time allows. Careful attention is paid to what individual scientists taught, what ideas they advanced, and how influential they were in the science that followed. The end result of this kind of presentation is what we would like to call our orientation.

Outside lecturers, laboratory work, field trips, special sessions, and audiovisual materials give the student a wide range of experiences in the instruments and techniques of science. Required outside readings and research provide a rare opportunity for enriching the mind and enhancing the scientific understanding of any student who will avail himself of the opportunity.

Our problems, as presented previously in this report, are those that affect any other academic department. We find satisfaction in the fact that a very small percentage of our difficulties are due to the students studying science. This seems to be an indication that we are "breaking through" to the students. Thus we have accomplished the goal we sat for ourselves at the programs inception. We have actually received letters of appreciation from students who took our course. The unofficial report that spreads around the student body confirms the opinion that we are getting somewhere in this approach.

Students get inspired over a subject and the faculty is challenged in the presentation of the subject, we feel these signs are indications that the probing is in the right direction and that the situation justifies our planning and our efforts.

PHYSICAL SCIENCE LABORATORY

The laboratory experiments used during the past eight years in the physical science course were designed to help the students become further acquainted with the concepts and ideas presented in the lectures. As with the rest of the course, the stress is placed primarily on concepts rather than mathematical manipulations whenever possible. In some cases, however, this was not possible as the ideas involved required a certain amount of analysis in order for them to be brought out in the course of the experiment. In these cases, a program of graphical analysis was adopted as the simplest procedure that would obtain the desired result.

The result observed from the laboratory program has been that the students were able to come away from the laboratory sessions with at least a better understanding of the ideas involved in the content of the individual experiments. The experiments were designed so that the instructor would give a brief lecture at the start of each session covering the ideas and concepts involved in the experiment, an exhibition of the equipment to be used and its operation, and some comments on the way in which the results were to be analyzed. The students were given an opportunity to ask questions as a group before they began their portion of the exercise.

During the student's work, as much opportunity as possible was given for them to make their own discoveries concerning the principles involved

with a minimum of interference or distraction from the instructor. With a student-teacher ratio of about 15 to 1, on the average, sufficient opportunity was available for answering any and all student questions to the student's satisfaction. It was felt that this would allow the maximum impact on the student for determining by himself the desired results of the experiment. This acts, we have found, to allay his initial fears concerning science in general and the laboratory in particular and is most effective in removing science from the realm of "magic" into the realm of understanding, and a logical process.

Within the limitations imposed upon the laboratory program, it has been a success. Students acceptance of and interest in the laboratory experiments has been observed to be continually improving with each semester. The problems encountered are being systematically removed with each repetition of the sequence of experiments.

During the course of the program the entire series of experiments were completely rewritten. This restructuring of the program was found to be more effective in creating student enthusiasm than the series used originally. Of the fourteen original experiments, approximately six were found to be unsuitable for students involved in the Cooperative General Science Program. These were either replaced completely or were rewritten. Out of this sequence, approximately three of the experiments were found to be less than completely satisfactory in terms of effectiveness and illustration of the desired principle. These experiments were revised and an additional group of experiments were prepared and incorporated into a laboratory manual which was published by Addison-Wesley.

There were three problems that should be mentioned in connection with the laboratory program which were eventually solved. First, we were hampered and delayed in implementing our planned program by the length of time encountered between ordering and receiving supplies and materials for new laboratory experiments. This was a problem that resolved itself eventually. But, in the meantime, experiments that we would have preferred to present had to be omitted and replaced by others. Second, was the problem of scheduling experiments in such a manner that they would coincide with the lecture topics. This problem was most acute at the beginning of a semester when exercises had to be planned to acquaint the students with the laboratory and the methods that will be employed for data analysis and so forth. This has been resolved to a great extent, but the basic problem will always be present to some degree. Third was the vast amount of materials that could be covered in order to give the students the fullest possible background. This was counteracted with each review of the overall program. The final result is a series of experiments that go into selected topics in depth.

BIOLOGICAL SCIENCE

The cooperative General Science Program has certainly played a paramount role in aiding the non-science major to be aware and more appreciative of science and scientists in our society. It has caused the student to become more involved in science. Prior to the introduction of the Program into the Center, most non-science majors showed little or no interest in science. Today, this negative attitude toward science has almost disappeared.

There is little doubt that the biology taught in the Cooperative General Science Program has had a great impact on the students and teachers in the Center. The very nature of the cooperative aspect of the program almost immediately assured its success over the traditional way of teaching biology for the non-science majors. Before the beginning of the Cooperative General Science Program, each school treated science differently. Two had lectures but no laboratory. The number of credit hours for the course varied at different institutions and only two schools offered any form of physical science and one year of biology for the science requirement. The direct thrust at improving and making experiences in the laboratory more meaningful has enhanced the outlook on science.

The lectures and the laboratory experiences in this program supplement each other. Every effort is made to assure the student of this. As a general rule, the student has attended special sessions and lectures pertaining to upcoming laboratory exercises before he is allowed to proceed on his own. Because of this briefing prior to the laboratory exercise, the student is better able to carry out his assignment.

Indirectly, this program has made great changes in the teaching of science throughout the Center. It has placed considerable equipment on each campus. It has made it possible to release faculty members to concentrate more time on biology majors and research since the program has its own staff. It has caused real cooperation among the institutions and it has brought the students closer so that a true exchange of ideas may take place.

The program is a very successful one but, as in all innovations, problems did arise. However, the truly successful point far outweigh any shortcomings of the program. Weekly meetings are held to discuss the program and the upcoming assignments. An attempt is made to make sure that each staff member is fully aware of what is going on. The exercise for the week is discussed and analyzed for possible pitfalls. Any problems that may have arisen or anticipated are deliberated and some decision made relative to them.

Equipment has always been a major item in conducting a very interesting and efficient course in biology. In this Program, considerable equipment is available and funds are on hand for audiovisual aids, guest lecturers and field trips. These are truly important in the success of a program in any science course. Of course, the contributions of the staff members to the program is recognized to be of prime importance.

The counseling and very close contact with the students by the staff members have helped greatly. This kind of program could possibly be initiated at other campuses, but these institutions are ideally located for the implementation of a cooperative project for several hundred students.

BIOLOGICAL SCIENCE LABORATORY

The laboratory approach has afforded many students the opportunity of gaining greater knowledge, and, therefore, greater facility in grasping scientific principles. In the process of teaching these students, the scientific method is not overlooked in procedure or in presentation. The combined effort of the lecture-laboratory method has proved to be

beneficial to the students by presenting the same information to a large number of students in large lecture classes, and by giving each student personal attention in smaller laboratory groups.

The laboratory instructors have added to the effectiveness of the course by their recent knowledge of academic and technical advances due to their recent studies or technical employment. Their varied backgrounds have enhanced the development of the laboratory exercises perormed. This feature has made it possible for the students to become more cognizant of scientific methods resulting from historical and contemporary achievements. It should be noted that greater emphasis was given the modern biological concepts and procedures in the laboratory exercises. The object of these exercises, devised and written by the faculty members affiliated with the course, was to present experiments that would complement the lectures while making reference to the anatomical, physiological as well as morphalogical composition of the students.

Inducing non-science majors early in their collegiate experiences to seek careers in biology was the challenge for most of the instructors. The students are introduced to general biology as well as the wide array of specializations with the broad areas. Field trips and individual experimental exercises allowed for student mobilization and interpretation of biological materials.

IMPACT AND INFLUENCES ON COOPERATING COLLEGES

The four undergraduate institutions in the Atlant University Center have been cooperating for the past several years. But, this program, more than any other, has made each school aware of the tremendous advan-

tages of pooling resources for greater strength and unity. There is freer movement of faculty and students from campus to campus at all levels of learning and in all areas of academic concerns. Each of the undergraduate colleges had a different offering for the non-science student: two colleges required only biological and physical science, but no laboratory or field work: one college permitted students to enroll in a general science program only at the sophomore level; while three colleges allowed freshmen to enroll in biological science or physical science. The Program has helped to bring about some kind of uniformity in the requirements for non-science students.

Aside from the immediate impact on the non-science majors, the new faculty and staff involved in the program were of special benefit to the total science program in the Center. Several faculty members came with varied experience and talents and they brought with them new ideas and innovations in teaching methods. This program has provided us with data and pertinent information about the weaknesses of students who had no training or exposure to any of the sciences, but who found themselves confronted with the task of making an adjustment ot the scientific enterprise in real life.

Presently, several colleges throughout the United States are using our published books. curriculum approach, and philosophy in their own schools. If you are interested, we will be pleased to send you a list of all colleges using our curriculum and books. Also, we have received about five hundred inquiries from colleges and universities in the United States and abroad pertaining to this program.

The key to the success or failure of this kind of course will not be found in any text or laboratory manual. The materials that we are developing can only be considered as an aid to the development of a science course for liberal arts majors. We feel strongly that the instructor of this kind of course must approach the students in an entirely different manner than found in traditional science courses. The choice of instructors is of prime importance in establishing such a course.

As a direct result of the success of the Cooperative General Science Program approach and its widespread acceptance, our program has received additional grants from the United States Office of Education to conduct six week summer training programs for college teachers of general science. The summer of 1973 was the second year of operation of these summer institutes for college teachers.

COOPERATIVE GENERAL SCIENCE PROGRAM
at
Clark, Morehouse, Morris Brown and Spelman College

STUDENT EVALUATION QUESTIONNAIRE

Except where otherwise noted, use the following key for recording your answer on the answer sheets: A = strongly agree B = agree, C = disagree D = strongly disagree. Use only a number 2 lead pencil.

1. The objectives of the course were made clear by the instructor.

   A. (60%) B. (32%) C. (5%) D. (1%)

2. The instructor was well prepared for class

   A. (66%) B. (30%) C. (2%) D. (0%)

3. The lectures were interesting and stimulating most of the time.

   A. (18%) B. (40%) C. (25%) D. (16%)

4. The instructor utilized the class time in an effective manner.

   A. (47%) B. (42%) C. (7%) D. (3%)

5. The instructor raised interesting questions for the class to consider

   A. (20%) B. (42%) C. (24%) D. (12%)

6. Students were free to express their opinions in class

   A. (41%) B. (36%) C. (16%) D. (6%)

7. The instructor seemed genuinely interested in each student as an individual.

   A. (34%) B. (38%) C. (18%) D. (7%)

8. The instructor was receptive to the ideas and views of the students

   A. (24%) B. (50%) C. (17%) D. (5%)

9. The instructor clearly defined the responsibilities of the students in the course.

   A. (55%) B. (35%) C. (7%) D. (2%)

10. The instructor provided adequate time for student consultation and assistance.

    A. (50%) B. (38%) C. (7%) D. (2%)

11. The part I gained the most from was: A. Lecture B. Homework Assignment C. Laboratory D. Term paper

    A. (33%) B. (28%) C. (31%) D. (3%)

12. I think that the course added to my understanding of science in general.

    A. (37%) B. (44%) C. (12%) D. (4%)

13. The content of this course was shown to have relevance to the things I am interested in.

    A. (17%) B. (34%) C. (32%) D. (15%)

14. Generally, the laboratory exercises complemented the lecture materials and added to their understanding

    A. (37%) B. (48%) C. (11%) D. (2%)

15. The experiments done in the laboratory were challenging and exciting.

    A. (32%) B. (42%) C. (19%) D. (5%)

16. Generally, I would rate the textbook as: A. excellent, B. good, C. satisfactory D. fair E. poor

    A. (11%) B. (37%) C. (34%) D. (11%) E. (4%)

17. The examinations adequately covered materials from the lectures, laboratory exercises and reading assignments.

    A. (52%) B. (39%) C. (5%) D. (2%)

18. The examinations were graded fairly and accurately.

A. (43%) B. (46%) C. (7%) D. (3%)

19. The laboratory work was graded fairly and accurately

A. (42%) B. (47%) C. (8%) D. (2%)

20. Now that you have taken the course, would you recommend it to a friend if it were not required for credit?

A. Yes (59%) B. No (38%)

COOPERATIVE GENERAL SCIENCE PROGRAM
at
Clark, Morehouse, Morris Brown and Spelman College

STUDENT EVALUATION QUESTIONNAIRE

Except where otherwise noted, use the following key for recording your answer on the answer sheets: A = strongly agree B = agree C = disagree D = strongly disagree. Use only a number 2 lead pencil.

1. The objectives of the course were made clear by the instructor

   A. 61% B. 36% C. 2%

2. The instructor was well prepared for each class

   A. 62% B. 31% C. 4%

3. The lectures were interesting and stimulating most of the time

   A. 44% B. 48% C. 4% D. 1%

4. The instructor utilized the class time in an effective manner

   A. 44% B. 48% C. 4%

5. The instructor raised interesting questions for the class to consider

   A. 33% B. 51% C. 15%

6. Students were free to express their opinions in class

   A. 59% B. 34% C. 3%

7. The instructor seemed genuinely interested in each student as an indi - vual

   A. 48% B. 41% C. 9% D. 1%

8. The instructor was receptive to the ideas and views of the students

   A. 46% B. 47% C. 4% D. 1%

9. The instructor clearly defined the responsibilities of the students in the course.

   A. 48% B. 46% C. 4%

10. The instructor provided adequate time for student consultation and Assistance.

A.47% B. 41% C. 9%

11. The part of the course I gained the most from was:

A. lecture B. homework assignments C. laboratory D. term paper

A. 74% B. 8% C. 13% D. 3%

12. I think that the course added to my understanding of scinece in general

A. 43% B. 47% C. 21% D. 5%

13. The content of this course was shown to have relevance to the things I am interested in.

A. 18% B. 53% C. 21% D. 5%

14. Generally, the laboratory exercises complemented the lecture materials and added to their understanding.

A. 24% B. 54% C. 14% D. 3%

15. The experiments done in the laboratory were challenging and exciting

A. 16% B. 41% C. 34% D. 6%

16. Generally, I would rate the textbook as

A. excellent B. good C. satisfactory D. fair E. poor

A. 7% B. 36% C. 36% D. 13%

17. The examinations adequately covered materials from the lectures, laboratory exercises and reading assignmetns

A. 39% B. 53% C. 6% D. 2%

18. The examinations were graded fairly and accurately

A. 42% B. 46% C. 8% D. 2%

19. The laboratory work was graded fairly and accurately

A. 41% B. 46% C. 8% D. 2%

20. Now that you have taken the course, would yourecommend it to a friend if it were not required for credit?

A. yes B. No

A. 73% B. 21%

CGS PROGRAM

FACULTY EVALUATION

1. In your mind, what are the goals of the CGS Program and what part do you imagine yourself to be playing in regards to these goals?

2. a. List and explain specific academic benefits which you believe students ought to derive from the course.

   b. Do you think these are actually provided? Why or why not?

3. Is there a new "kind" of teacher emerging in the CGS Program? What are his characteristics? What are his allegiances?

4. a. What does the program do for you professionally?

   b. Does it stimulate you intellectually? How?

   c. In what other ways does it benefit you or liberate you?

5. a. In your mind, what is the best way for other institutions to benefit from our experience with this course?

   b. What is the best way for us to benefit from our own experience?

   c. What is the best way for the students to benefit from it?

6. a. Classify and characterize the various ways which you believe this course ought to benefit the students as human individuals.

   b. Do you think these benefits are actually provided? Why or why not?

   c. Do you believe that it is dangerous or that you have failed if a student develops an adverse opinion of science during the course? Why or why not?

7. Name some specific innovations and their purpose that you think we ought to adopt or use more extensively.

8. a. What innovations do you think we will employ in the next two years?

   b. What new materials need to be presented to our students? What needs to be eliminated?

9. What is the specific value of our material? (Concepts in Physical Science, Experiments in Physical Science and Biological Science Laboratory manual).

10. If you have any other opinions, please let me know about them.

FACULTY EVALUATION

1. *What are the goals of the CGS Program: ...*

   The goals of the CGS Program are

   A. To develop a positive attitude toward science

   B. To understand the interconnections between technological advancement and human affairs

   C. To provide students with realistic and practical knowledge of the basic concepts and techniques of science in order that they may become functional citizens in a scientific society.

   D. To understand the dependence of society upon scientific research and technology

2. *Specific benefits....*

   A. A basic understanding of the unifying concepts of the subject matter so that the student is "scientifically literate".

   B. To be able to utilize the acquired knowledge in science to perform more adequately on standardized exams such as the GRE (Graduate Records Exam) and the NTE (National Teachers Examination) to facilitate employment and entrance into graduate school.

   C. To develop the "Attitudes of Science" that include the following components (1) a desire for proof or verification, (2) precision avoid vague emotional statements, (3) to be openminded and willing to change opinions, (4) suspension of judgements until inves-

tigations are made, (5) adversion to superstition and (6) scepticism avoid taking things for granted.

D. To be able to appreciate the importance of science in understanding the modern world, the use of procedures of science for their use in discovering new knowledge and extending presently developed knowledge, and the history (origin and development) of science.

b. these things are provided....

Yes, we do feel strongly that the students are provided these benefits. Concrete data is needed to determine if students actually achieve from the course those things that were intended.

3. New kind of teacher....

Yes, we do think that a new kind of teacher is emerging in the Cooperative General Science Program. The characteristics of this new teacher are:

A. a broad background preparation in his subject area.

B. a knowledge of the teaching process and a love for teaching

C. Studies teaching as actively as he studies his subject matter

D. Students can easily relate to this new teacher.

The new teacher's allegiances are to the students and the teaching process.

4. For you professionally....

Professionally, the program offers an opportunity to develop and use innovative teaching techniques and materials and test the effectiveness of these developments using a large and representative sample college students.

b. Intellectually....

Intellectually the program is stimulating because it offers opportunities to debate ideas with other program professors relative to the teaching process.

5. *Institutions benefit....*

By commercially preparing our materials for their use.

By sponsoring summer institutes for training other teachers to use our materials and techniques and by presenting papers about our program at professional meetings

b. Program benefit....

by continuing to use student evaluations to evaluate our own teaching and to modify the course structure through continued exchange of ideas between the various members of the faculty group (Biological and Physical Science).

c. Student benefits....

Students can best benefit when the above mentioned ideas in 5a and 5b result in the best possible course for each student to pursue.

6. *classify and characterize benefit to students....*

The four basic human needs that this course should address itself to are: 1. a need to belong or identify with what is being done. Students are not likely to be satisfied when they are merely spectators of events far removed from their experiences 2. to understand.. students

have a basic need to understand. The course and the teacher must recognize and appreciate this predisposition to understand 3. Independance - students should be afforded opportunities to do things (learn) on their own, and 4. Creativity - students have a need to be creative. Courses should be taught so that students are led to discover some concepts on their own. Each discovery is a creative experience.

b. Benefits provided....

Yes, we think that these benefits are actually provided. The course does stress the humanistic aspects of science and instructors do attend to the needs identified in the above answer.

c. Develops an adverse opinion of science....

Yes, we would feel that we have failed if students develop an adversion to science during the semester. The reason being that one of the major objectives of the course is to develop positive attitudes toward science.

7. *Innovations ....*

Some innovations that we could adopt and use more extensively are:

A. Individualized Modules - they allow students to learn at their own rate, students are evaluated in terms of progress as opposed to group standards and it reduces the pressure of competing with classmates for grades.

B. Inquiry Modules - give students more opportunity to direct and control his own learning, and inquiry stimulates the student in the pursuit of new knowledge.

C. Test Data - to facilitate effective immediate and long range planning, identify student learning problems and to evaluate teaching techniques.

D. Research Projects - to offer more independent and self directed learning.

8. Innovations next two years....

We think that items identified in number 7 will be implemented in the next two years (some are already being used) and used rather extensively.

b. New materials presented or eliminated....

We think that topics and concepts being currently offered are up to date and relevant. We feel that they should be retained but presented using a wider variety of teaching techniques

9. value of our materials....

Our materials are of value because they have been developed locally with our specific needs and goals in mind. They attend to basic student needs and at the same time, offer an opportunity to explore the subject matter in an investigative manner.

FACULTY EVALUATION

1. *What are the goals of the CGS Program:...*

The goals of the CGS Program are to offer meaningful and relevant courses in the physical and biological sciences to liberal arts students. These courses must be presented in a manner which does not conflict with the "world-view" of a liberal arts students, that is, they must focus on science from a humanistic, philosophical and historical perspective rather than from a technical, mathematical and manipulative point of view. The purpose of the program is not to produce scientists, but rather to give the general liberal arts student an appreciation for science as an expression of man's intellect attempting to understand the world in which he lives. He should gain a feeling of the beauty and unity of science, for the role science plays in society today, and for the problems, and the solutions to problems, of our highly technological world.

The CGS Program involves a student in a true "learning experience". He comes in contact with his lecture instructors and laboratory instructors. He interacts with other students both in the laboratory and in the seminars. He is involved in a two semester series activities which have been carefully planned and executed to give him full exposure to science, the scientific method and scientific

and scientific thinking. It is hoped that no student will be able to go through this experience and not be affected in some way.

As far as the part the instructor plays in regards to these goals, our physical science classes have been aimed at achieving these goals for the students enrolled in our sections. We also believe that some of the innovations that we have helped to introduce into the course have aided in reaching these goals.

2. Specific benefits....

The specific academic benefits which a student should derive from the course are:

A. An appreciation for the beauty and unity of science

B. An understanding of the historical development of scientific concepts

C. An understanding of the place of science in today's world

D. A comprehension of the basic underlying principles of physical Science

E. A basis for making intelligent decisions about science as a citizen of his country.

b. These things are provided....

We feel that all of the above are provided for by the Cooperative General Science Program because it is specifically designed and tailored to give these benefits to the student.

3. New kind of teacher....

The Cooperative General Science staff is a group of people who are very dedicated to teaching. They are interested in the students, they

are well trained, and they are sincere and serious workers. There is no internal friction among members of the staff. They all cooperate to an extraordinary degree and seem to share the feeling that the most important aspect of their job is to offer the students a really first class program.

4. For you professionally....

We feel that we are better teachers due to our participation in this program. It has also given us an opportunity to become involved in curriculum development as well as the liberty to explore some innovative teaching techniques.

b. Intellectually....

The program stimulates intellectually in several respects. For example, the contact with non-science students has led us to evaluate more carefully the premises on which our scientific concepts are based, it has led us to investigate more fully the history and philosophy of science. It has also led us to study the problems involved in the teaching of science.

c. benefit or liberate....

The program has also benefited in several respects. It has given us the opportunity to present papers at professional meetings on new approaches to teaching physical science, it has given us a chance to help develop laboratory experiments, and it has allowed us the freedom to explore new ways of presenting the materials.

5. Institutions benefit....

The best way for other institutions to benefit from our experience with this course is by producing materials which can be utilized by other schools offering similar courses. For example, the physical science textbook has been adopted by many colleges and universities. Another possibility is to develop a set of laboratory experiments which could be marketed either as kits or as a complete lab course. That is, we could design a series of experiments and a set of equipment, instructions and questions for each experiment.

Alternative ways in which other institutions can benefit from our experience is for us to deliver papers at professional meetings and by offering summer institutes.

b. Program benefit....

The best was for us to benefit from our experiences is through student evaluations, self-evaluations, such as this one, and by having a closely unified group teaching the course so we can interact and benefit from each other's experiences.

c. Students benefit....

The best way for the students to benefit from our experience is for us to use it to produce as good a course as we are able to offer. Many students have commented favorably on the course because they feel that it is doing a good job of teaching. They appreciate the course content, outlines and course rules which they receive at the beginning of the

semester. They also have expressed appreciation for the fairness of the grading in the course. Thus it appears that the students are benefiting from our experience.

6. Classify and characterize benefit to students....

This course should benefit the students as human indivuduals in the following ways:

A. it should give them the familiarity with scientific concepts which is expected from any college person.

B. it should give them an idea of what science is and what it is that scientists do.

C. it should teach them some of the terminology of science. For example, at the end of the course the student should know the significance or meaning of concepts such as: quasars, elementary particles, nuclear fission, cosmology, the theory of relativity, quarks, thermodynamics, quantum jumps and so forth.

D. the course should give the student some practical information to help him understand the technological world of today. For example, he should know what is meant by concepts such as voltage and electrical power. He should have a qualitative understanding of television. He should understand why a perpetual motion machine is impossible. He should acquire enough information and background to understand the problems of pollution and the energy crisis.

b. Benefits provided....

All of these benefits are provided by the course as it is presently organized and taught.

c. Develops an adverse opinion of science....

When a students says that he would like to take another science course, we feel that we have been successful. When a student develops a dislike for science, we feel that somehow we have failed. We would not mind if a student came to an adverse opinion of science if he understood what science is all about, after all, many scientists have adverse opinions of other fields. However, if a student forms an adverse opinion of science because the course is presented in such a way as to "turn him off", then the course and the instructor have been a failure. Such a failure is dangerous because our students are not just ordinary citizens. As college educated people, they are expected to be leaders. Their opinions will be respected in their community and will be reflected by their representatives. Therefore, an adverse opinion of science based on a poorly taught or poorly run science course can have effects beyond the personal disenchantment of the individual student.

7. Innovations....

Some specific innovations which we might use more extensively are the use of seminars and research projects. We require that students either participate in a seminar, do a research project, or write a term paper. The purpose is to increase the personal interaction between student and teacher, to get the student involved in some sort of out of class project, and to help tailor the course to the individual abilities and interests of each student.

In the seminars a group of about ten students and the instructor meet on a specified afternoon and each student gives a five to ten minute talk on a previously arranged topic. For example in the seminar on air pollution, each student will discuss one of the following topics:

1. Sources of air pollution
2. Role of air pollution control boards
3. Legal aspects of air pollution control
4. Meterology and air pollotion
5. Description of air pollution episodes
6. Pollution and the energy crisis

Each student has a different topic. During the seminars, the student interact with each other with questions and comments. The discussions are usually quite exciting.

We have scheduled seminars on : Black Scientists, Astrology, Air Pollution, The Energy Crisis, Unidentified Flying Objects, Science and Society, and other subjects. The seminars are very popular with the students.The other alternative to a term paper is the research project. We have made up a set of research projects which require that the student do some scientific work on his own. We feel that this is one way to reach the superior student who might feel that the course is not offering him a challenge. Through the research project the student interacts on a one to one basic with a scientist, he designs and carries out a simple scientific project and submits a final report. Naturally, most students will option for the easier alternative of doing a term paper or

participating in a seminar. Nevertheless, many students have decided to do research projects.

We would like to try to use closed circuit television demonstrations again. The instructor could tape a series of demonstrations lasting about 5 minutes each, and then, at appropriate times during the semester, he could have the demonstration played back on the closed circuit system. We realize that the taped lecture is considered to be very dull by most students, however, short taped demonstrations might prove to be interesting. It would also be a great time saver for the instructor as he could use the tapes during subsequent semesters.

8. Innovations next two years....

I believe that during the next two years, we will use the seminar and the research projects more extensively in our course. Naturally, this will depend on student reactions to their using more time and work in these areas.

b. New materials presented or eliminated....

New materials that should be presented to our students are a short introduction to ecology and pollution problems and a short section on some of the more recent advances in physics and astronomy.

It is hard to say what materials should be eliminated from the course. The historical approach should, perhaps, be played down, and the Ptolemaic system of astronomy could be made shorter. However, all in all, the course, as outlined in the textbook is very good and there is no real

need to eliminate any part of it. Naturally, when a revised edition of textbook is written, some parts will probably be eliminated, but this would have more to do with the personal preference of those doing the editiong than with any failing of the book itself.

9. *Value of our materials....*

Our materials is excellent. The textbook is on the right level for our students and it presents the subject matter from a point of view that is meaningful to them. The book is well written and nicely put together, good illustrations, etc.

The textbook, laboratory manual and teacher's guide are valuable in that they form a "ready made" course which can easily be adopted for use by some other college or university.

STUDENT CONTRACT

This course will consist of three parts:

1. *Readings, homework assignments and quizzes*
2. *Laboratory exercises*
3. *Lecture examinations*

The laboratory manual, *Laboratory Investigations in Biological Science*, by Dr. M. R. Webb, CGSP, Revised Experimental Version, may be purchased from the bookstore. The textbook, *From Cell to Philosopher*, Michael D. Nicklanovich, Prentice-Hall first edition may be purchased there also.

Part I. Projects, Home assignments, and quizzes: 30% of your final grade

Lectures three times a week on Mondays, Wednesdays, and Fridays covering the subjects as given in the course outline. In addition to the textbook readings and supplemental handouts, there will be scheduled homework assignments and projects during the semester which should be turned in no later than the due dates determined by your instructor. Homework assignments will be assigned by your lecture instructor. Pop quizzes over material covered in lecture and textbook readings may be given during regular lecture sessions.

SPECIAL NOTE: Pop quizzes and home assignments will be given during scheduled lecture periods. Make up quizzes or home assignments will not be given. You will not be able to pick up or return home assignments at the office. If work is not returned to your instructor by the due date, a grade of zero will be recorded. Exceptions will be made only for official excuses from the office of the Dean of students at your respective schools or from your doctor.

Part II. Laboratory Exercises: 30% of your final grade

There will be twelve two hour laboratory periods during the semester for performing the experiments as listed in the laboratory experiment schedule. You will be allowed to drop your two lowest grades in the laboratory. Other details of this part of the course will be given by your laboratory instructor.

Part III. Lecture Examinations 40% of your final grade

Three one hour lecture examinations will be given on the scheduled days as indicated in the course outline. As a means of determining the amount of general knowledge gained from the course, an objective type final examination will be given only on the hour and date set for the final examination by the Atlanta University Colleges. The final exam will cover a two hour period. Materials to be covered on the final examination will be discussed by your lecture instructor.

if you have to be absent on the scheduled day of the examination, arrangements must be made with the instructor for a make up test prior to the date of the test. Unforseen absences for sickness, accident, etc, must be made up within one week after you return to class. Otherwise a zero will be recorded for work missed.

Course Structure

A Introduction - *The Present status of Biology. The relationship between Biology and other disciplines. Biology and the future of man.* Two lecture periods. *Chemistry and Life - What is Life? The Chemical Basis of Life. The role of Enzymes in Life Functions.* Chapter I of textbook. Four lecture periods

Objectives

As a result of your experiences in lectures and reading assignments, each student in the class should be able to do the following:

1. List the characteristics or properties that distinguish between living and non-living systems.
2. Compare and contrast metabolism, anabolism and catabolism
3. List the statements of the cell theory
4. List the five major categories of biochemicals and the role that they play in living systems.
5. Compare and contrast atoms, ions and molecules
6. List and describe the five categories of chemical reactions
7. Describe the role of enzymes in biochemical reactions
8. Distinguish between enzymes and catalysts
9. Use the concept of pH to distinguish between acids and bases
10. Describe the role of buffers in living systems.

B *Levels of Biological Organization - Cellular Basis of Life. Technological Advances and Increased Knowledge. Cellular Energetics. The Steady State.* Chapter 2 of text. Four lecture periods First lecture exam: Friday.

Objectives

1. List and describe the levels of biological organization
2. Draw and label a diagram of a modern cell
3. List the cellular organells and give a function of each
4. Compare and contrast diffusion and active transport
5. Use cellular organells to demonstrate corelations between biological structure and function.
6. Compare and contrast photosynthesis and respiration

7. Compare and contrast anaerobic and aerobic respiration with respect to energy yields.
8. Distinguish between procaryotic and eucaryotic cells.
9. List the major stages in the evolution of higher cells.
10. Define the steady state

C *Regulation of the Internal Environment - The Role of Hormones in Biological Control. The Nervous System. The Execretory System. The Evolution of the Vertebrate Kidney* Chapter 3 of the text. Nine lecture periods
Second lecture examination Monday

Objectives

1. Define homoestasis and cybernetics
2. Describe the role of negative feedback in homeostasis
3. Locate the endocrine glands in the body and list the hormones secreted by each
4. List the major hormones, the role of hormone and the results of over and activity of each gland
5. List interrelationships between the various endocrine glands
6. Describe how nerve impulses are generated and propagated
7. Distinguish between the structure, function and organizational parts of the central, peripheral, and autonomic nervous system.
8. Diagram and label the components of a simple reflex arc, indicating the pathway of the nerve impulse
9. Explain the consequences of an improper functioning nervous system
10. List the homeostatic functions of the kidney
11. Trace the steps in the formation of urine from blood.
12. Define excretion and list the components of the excretory system of man
13. Explain the consequences, in writing, the consequences of improper functioning excretory system
14. Contrast excretion and the maintenance of salt and water balance in marine, freshwater and terrestrial vertebrates.

D *Reproduction, Growth and Development - The Estrous Menstrual Cycles. Biological control and Reproduction. The sex Act. Mitosis and Meiosis. The Evolution of Sexual Reproduction.* Chapter 4 of the text Eight lecture periods

Objectives

1. List and describe the phases of the menstrual cycle
2. Compare and contrast the estrous and menstrual cycles
3. Correlate the events of the ovarian and uterine cycles
4. Enumerate the hormones involved in the reproductive cycles and give their sources, their targets, their effects, their interactions, and their relative levels at various times in the cycles.
5. Describe the make up and mechanism of action of the birth control pill
6. Distinguish between the processes and the results of mitosis and meiosis
7. Outline and contrast the typical plant and animal life cycles
8. Contrast the methods and results of asexual and sexual reproduction
9. Explain the adaptive significance of sexual reproduction
10. Describe the photoperiodic regulation of animal and plant reproduction
11. Label diagrams of the male and female reproductive organ systems.
12. Describe three types of sexual determination.

E *Principles of Heredity - Mendelian Principles and their Application to Human Genetics. Multiple Alleic, Sex Linked and Sex Influenced Inheritance. The Hereditary Chemical. Genetics and Engenics.* Chapter 5 of text. Seven lecture periods. Third Lecture Examination Wednesday.

Objectives

1. List and define three of Mendel's major laws of inheritance
2. Use the Punnett square and algebraic methods to determine the genotypes add probabilities of offspring in monohybrid and dihybrid crosses.
3. Contrast linkage and independent assortment
4. Distinguish between dominant inheritance and intermediate inheritance (incomplete dominance); multiple gene and multiple allelic heredity; Sex linked and sex influenced traits. Give examples of each.
5. Give the F_2 phenotypic and gentoypic ratios characteristic of monohybrid and dihybrid crosses and their test crosses.
6. Describe the genetic code
7. Compare the normal and the mutant gene
8. List three characteristics of mutations
9. List several causes of mutation
10. Define the following terms: a. Haploid b. Diploid c. Gamete d. Allele e. Homozygous f. Heterozygous g. Dominant Genes h. Recessive Genes i. Dihybrid Cross j. Monohybrid

F *Biological Change Through Time. Evolution - History of Evolutionary Thought, Evolution and Religion. A brief History of Life on Earth. Evolution in our Time* Chapter 6 of text. Five lecture periods

Objectives

1. Contrast evolution and special creation
2. List three characteristics of the fossil recored that can be explained by evolutionary theory
3. Distinguish between homologous and analogous organs
4. Contrast the evolutionary theories of Darwin and Lamarch
5. List four great principles which led Darwin to evoultion
6. Summarize the five points of Darwin's evolutionary mechanism
7. Define the species three ways and criticize each definition
8. Explain the potential roles of isolation and genetic drift in evolution
9. List three sources of variablility; cite three types of adaptations
10. Describe three types of selection
11. Compare the composition of the primitive and modern atmosphere
12. Outline Miller's experiment and explain its significance
13. Compare and contrast adaptive radiation and convergent evolution
14. Analyze the famous cases of industrial melanism, DDT resistance and Sickel Cell Anemia in evolutionary terms.

G *Principles of Ecology - The Abiotic Environment. The biotic Environment Pesticides and Pollution. Judgement* Chapter 7 of text. Six lecture periods Final Examination See Exam schedule

Objectives

1. Discuss the role of physical environmental factors such as temperature pH, salinity, water, and aeration in determining the composition of biotic communities
2. Diagram the carbon or nitrogen cycles
3. List, define, and exemplify five types of organismal interactions.
4. List the four major nutritional categroeis of organisms in a biotic community
5. Construct and compare the pyramids of energy, numbers, and biomass
6. Trace several routes by which energy is lost in the transfer from one trophic level to the next.
7. Express the mathematic relationship between population, biotic potential, and environmental resistance.
8. Discuss the stress theory of natural mammalian birth control
9. Distinguish between ecologic and physiologic death
10. List the six major land biomes and describe their physical characteristics, list representative animals and plants in each
11. List and describe the stages of an ecological succession from pioneer to climax communities
12. Contrast biologic control and the use of pesticides
13. List seven types of pollutants; describe their effects and recommend corrective measures or alternatives
14. Compare the cellular, organismal, and ecosystemic steady states

STUDENT CONTRACT

General Information

This is a very large course in numbers of students, and for this reason, requires a more extensive organization than most courses you will take during your college career. One aspect facilitating this organization is that all work turned in for credit will be graded by a computer *with the exception of term project and perhaps the major examination. Special answer sheets suitable for computer grading will be provided to you. Remember always that a computer works very fast and never makes mistakes, but has the disadvantage of also being extremely stupid. It cannot, for instance, read marks made with a ball point pen,* always have a soft #2 pencil with you.

During the second week of class meetings you will be assigned a CGS number and a seat in the lecture room. If you desire a seat in one of the front rows of the classroom, you should advise your instructor during the first week of class. Be sure to learn your CGS number as this will be your identification to the computer.

On Monday of each week you will be given a short handout outlining the materials to be covered during the week. Regular class attendance is extremely important in this course. It is not possible to get a good grade if you miss many quizzes, laboratories, and so forth. You can't pull it out with a good grade on the final. All handouts will be available at the end of regular classroom periods.

Read your school's policy on absences carefully it's given in your school catelog. Absences will be recorded and reported to the dean of your college.

You should purchase the following materials for this course, all are available in the bookstore.
Textbook, Concepts In Physical Science. Manual, Experiments in Physical Science, by the CGSP Staff. A 3 hole notebook, a package of square-ruled graph paper and a sufficient quantity of number 2 pencils. The notebook should be used to keep all handouts and class notes.

This course will consist of five parts: *1. Weekly Quizzes 2. Laboratory 3. Major Examinations 4. Term Project 5. Final Examination*

Part I. Weekly Quizzes: <u>20% of your final grade</u>

Every Friday during the semester (except on weeks in which a major exam is given), you will hand in a quiz paper. The quiz may be a short ten

to fifteen minute in-class quiz at the end of Friday's class, or it may be a take home quiz. Quiz papers may only be turned in for credit at the end of class on Fridays. If a take home quiz is given, it will be given to you on Monday to turn in on Friday. Each quiz will cover the material presented during that week, and the grades given for the quizzes will be posted on the walls of the lecture room by CGS numbers. Your two lowest quiz grades will be dropped when calculating your final grade. Missed quizzes will receive a grade of zero. Because the two lowest grades are dropped, missed quizzes cannot be made up except when due to authorized absences.

Part II. Laboratory: 30% of your final grade

There will be twelve laboratory periods during the semester for performing the experiments listed. Each laboratory will be two hours long. No missed laboratories may be made up after the week during which they are scheduled.

Part III. Major Examinations: 30% of your final grade

Three major examinations will be given on pre-announced dates. Major examinations will cover specified chapters of the textbook and class notes

Part IV. Term Project: 10% of your final grade

The term project is an important part of your work in the course. It gives you the opportunity to do original work and to explore the relationships between the concepts of physical science and the particular fields of your interest. There are three options available to you for the term project: A. Term Paper, using at least three references, that shows the relationships between physical science and some topic that holds particular interest to you. The latest date on which a term paper may be submitted for credit will be two weeks before the final examination. B. Research Project, students are incouraged to do an original research project. Suggested research topics will occasionally be mentioned on handout sheets. The details of a research project will be worked out between you and your instructor. C. Seminar, This is a short talk on a Physical Science subject delivered by you to a seminar group. These seminars will be scheduled on specified topics during the term and will be announced by the instructor.

Part V. Final Examination: 10% of your final grade

A comprehensive final examination will be given on a date determined by and required by the Atlanta University Center Colleges. This will be a two hour examination.

The total number of points you accumulate during the term will determine your final letter grade in the course: 90-100 A, 80-90 B, 70-80 C, 60-70 D, less than 60 F.

Course Structure

A Introduction Two lecture periods References: The introduction and Chapter 2 of text

Objectives:

1. Description of the course and course procedure
2. Discussion of the Scientific method
3. Discussion of some of the relationships between physical science and other fields of endeavor, as well as everyday life.

B *Man's Mind Measures the World.* Five lecture periods Reference: Introduction and Chapter 1 of text

Objectives:

1. Description of techniques and units of measurement
2. Description of mathematics as the language and major tool of science
3. Development of the concepts of ratio, proportion, variable, function, rational numbers and irrational numbers interpret graphs

C *Concepts of Motion* Seven lecture periods References: Chapter 2 of text

Objectives:

1. Historical development of human concepts of motion from the ideas of Aristotle to the ideas of Einstein
2. Student grasp of the concepts necessary to describe motion

D *Architecture of the Universe* Four lecture periods Chapter 3 of text. First major examination.

Objectives:

1. Comparison of the geocentric, heliocentric and modern theories of the structure of the universe
2. Discussion of the size of the visible universe and the objects found in outer space
3. Modern developments and techniques in astronomy

E *Earth, Water, Air, Fire* Seven lecture periods Chapter 4 of text, handout material

Objectives:

1. Study of the historical development of chemistry leading to modern concepts of chemistry and the structure of matter.
2. Student understanding of simple chemical reactions, atomic structure, molecular structure
3. Student realization of chemical effects in everyday life
4. Discussion of air and water pollution

F *What makes the World Go 'Round?* Four lecture periods Reference: Chapter 5 of text, handout material Second Major examination

Objectives:

1. To develop the concept of energy as the unifying thread running through all the sciences
2. Develop and explore the relationship between work, energy and power in modern world
3. Discussion of the energy crisis, and alternative sources of energy for humankind

G *Particles in Motion* Four lecture periods Reference: Chapter 6 of text

Objectives:

1. Student understanding of the nature of heat phenomena
2. Description of heat transfer processes, the concept of temperature and the development and use of temperature scales
3. Study of the nature and properties of sound

H *Light - Messenger of the Universe* Three lecture periods Reference: Chapter 7 of text

Objectives:

1. Student understanding of the properties of light
2. Study of the nature of light and the physical distinction between different colors
3. Light other than the visible kind

I *From Thunderbolts to Television* Five lecture periods Reference: Chapter 8 of text Third Major Examination

Objectives:

1. Study of the simple properties of electricity and magnetism and the relationship between the two
2. Student understanding of simple D.C. and A.C. circuits commonly used in everyday life
3. Description of the connection between electromagnetism and light

J *The Earth in Time and Space* Three lecture periods Reference: Chapter 10 of text hand out material

Objectives:

1. Description of the internal and external structure of the earth as a planet
2. Description of the motion of continents

Final Examination

ORGANIZATION AND ADMINISTRATION

Dr. O. P. Puri, *Garfield D. Merner Professor*
Program Director

Dr. Vivian W. Henderson
President, Clark College

Dr. Hugh M. Gloster
President, Morehouse College

Dr. John A. Middleton
President, Morris Brown College *(1966-73)*

Dr. Robert Threatt
President, Morris Brown College

Dr. Albert E. Manley
President, Spelman College

ADVISORY COMMITTEE

Dr. A. S. Spriggs (1966-74) Department of Chemistry, Clark College

Dr. James Mayo (1966-72) Department of Physics, Morehouse College

Dr. W. F. Payne (1966-71) Department of Biology, Morris Brown College

Dr. Barnett Smith (1966-74) Department of Biology, Spelman College

Dr. Carl Spight (1973-74) Department of Physics, Morehouse College

Dr. A. Hankla (1971-72) Department of Physics, Morehouse College

Dr. J. Penn (1971-74) Department of Biology, Morris Brown College

COOPERATIVE GENERAL SCIENCE PROGRAM STAFF

PAST

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Mr. S. S. Bush, Physical Science
Ms. J. Hannah, Biological Science
Ms. S. Heath, Physical Science
Dr. W. Larson, Biological Science
Dr. W. B. Leflore, Biological Science
Dr. Robert Miller, Biological Science
Dr. A. G. McQuate, Biological Science
Mr. J. L. Padgett, Physical Science
Mr. Charles Prince, History of Physics
Dr. M. Scherago, Biological Science
Dr. K. K. Vijai, Physical Science
Mr. L. Singletary, Laboratory Manager
Mr. W. P. Thompson, History of Science
Mr. J. D. Wise, Physical Science
Ms. J. Bender, Biological Science
Dr. A. Dietz, Biological Science
Mr. D. Wood, Biological Science
Mr. E. Patterson, Physical Science
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Dr. J. Mayo, Physical Science
Dr. J. F. Moinuddin, Biological Science
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Dr. W. F. Payne, Biological Science
Dr. H. H. Rogers, Physical Science
Dr. K. Shaw, Biological Science
Mr. B. T. Simpson, Physical Scienc
Mr. J. Walker, Physical Science
Mr. W. Watkins, Biological Science
Ms. F. Yen Biological Science
Ms. K. Kaple, Biological Science
Mr. K. Waghrey, Biological Science
Mr. P. Rai, Biological Science
Mr. William Shackelford, Physical Science
Ms. R. G. Thompson, Program Secretary

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Mr. S. E. Sears, Biological Science
Mr. K. L. Basu, Biological Science
Ms. V. U. Merriweather, Program Secretary

Dr. P. J. Hamill, Physical Science
Ms. B. E. Nix, Physical Science
Ms. B. J. Holt, Physical Science
Dr. G. R. Brown, Physical Science
Mr. W. H. Knox, Physical Science

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Dr. H. Branson, Howard University
Dr. D. Cope, U. S. AEC (Oak Ridge)
Dr. L. Fredrick, Atlanta University
Dr. D. Holden, South Dakota ST Univ.
Dr. N. Kowal, Clark College
Dr. M. Manhas, Steven's Institute of Tech.
Dr. R. Rohrer, Emory University
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